

What is Claimed is:

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1. A method for producing a multilayer polyolefin foamed sheet comprising at least one polyolefin foamed layer and at least one polyolefin non-foamed layer, wherein the method uses a producing apparatus comprising at least one first extruder for extruding a material for forming a polyolefin foamed layer wherein the first extruder is equipped with a foaming agent-supplying device for supplying a foaming agent to a cylinder, at least one second extruder for extruding a material for forming a polyolefin non-foamed layer and at least one extrusion die for co-extruding the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer therethrough to form the multilayer polyolefin foamed sheet, the method comprising:

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a melt kneading step in which, in the first extruder, a resin material for forming a polyolefin foamed layer is melted and the melted resin material for forming a polyolefin foamed layer and a foaming agent supplied from the foaming agent-supplying device are mixed to form the material for forming a polyolefin foamed layer;

a melting step in which the material for forming a polyolefin non-foamed layer is melted in the second extruder; and

a co-extruding step in which the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer in their melted states are co-extruded into atmospheric pressure through the extrusion die and the extruded material for forming a polyolefin foamed layer is foamed to form the multilayer polyolefin foamed sheet.

2. The method for producing a multilayer polyolefin foamed sheet

according to claim 1, wherein the extrusion die is a circular die and the material for forming a polyolefin foamed layer and the material for forming the polyolefin non-foamed layer are co-extruded into a cylindrical form in the co-extruding step.

3. The method for producing a multilayer polyolefin foamed sheet according to claim 1, wherein the co-extruding step is conducted under conditions satisfying the relationship of

$$10 \geq Q \text{ (kg/hr)}/W \text{ (mm)} \geq 0.3$$

wherein  $Q$  (kg/hr) denotes the amount of the resin to be extruded through the extrusion die and  $W$  (mm) denotes a die lip diameter.

4. A producing apparatus for producing a multilayer polyolefin foamed sheet comprising at least one polyolefin foamed layer and at least one polyolefin non-foamed layer, the apparatus comprising at least one first extruder for extruding a material for forming a polyolefin foamed layer wherein the first extruder is equipped with a foaming agent-supplying device for supplying a foaming agent to the cylinder, at least one second extruder for extruding a material for forming a polyolefin non-foamed layer and at least one extrusion die for co-extruding the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer therethrough to form the multilayer polyolefin foamed sheet, wherein the extruding die has a diameter at its die lip,  $W$  (mm), which is in the range of not smaller than  $(1/10)Q$  (kg/hr) and not greater than  $(10/3)Q$  (kg/hr) wherein  $Q$  (kg/hr) denotes the amount of the resin to be extruded through the extrusion die.

5. The producing apparatus for producing a multilayer polyolefin

foamed sheet comprising a gear pump mounted between the at least one extruder and the extruding die.

6. The method for producing a multilayer polyolefin foamed sheet according to claim 1, further comprising a laminating step for laminating at least one multilayer polyolefin foamed sheet produced.

7. The method for producing a multilayer polyolefin foamed sheet according to claim 6, wherein the multilayer polyolefin foamed sheet co-extruded is folded up, superimposed and laminated together in the laminating step.

8. The method for producing a multilayer polyolefin foamed sheet according to claim 6, wherein the extrusion die is a circular die and the multilayer polyolefin foamed sheet co-extruded into a cylindrical form is laminated as it is or superimposed and laminated after being incised continuously along its longitudinal direction at at least one point.

9. A method for producing a multilayer polyolefin foamed sheet comprising at least one polyolefin foamed layer, at least one polyolefin non-foamed layer and at least one gas barrier resin layer, wherein the method uses a producing apparatus comprising at least one first extruder for extruding a material for forming a polyolefin foamed layer wherein the first extruder is equipped with a foaming agent-supplying device for supplying a foaming agent to a cylinder, at least one second extruder for extruding a material for forming a polyolefin non-foamed layer, at least one extrusion die for co-extruding the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer therethrough to form the multilayer polyolefin foamed sheet and a gas barrier resin sheet-

supplying device for supplying a gas barrier resin sheet to the multilayer polyolefin foamed sheet, the method comprising:

a melt kneading step in which, in the first extruder, a resin material for forming a polyolefin foamed layer is melted and the melted resin material for forming a polyolefin foamed layer and a foaming agent supplied from the foaming agent-supplying device are mixed to form the material for forming a polyolefin foamed layer;

a melting step in which the material for forming a polyolefin non-foamed layer is melted in the second extruder;

a co-extruding step in which the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer in their melted states are co-extruded into atmospheric pressure through the extrusion die and the extruded material for forming a polyolefin foamed layer is foamed to form the multilayer polyolefin foamed sheet; and

a laminating step in which a gas barrier resin sheet supplied from the gas barrier resin sheet-supplying device is laminated with the multilayer polyolefin foamed sheet to form a gas barrier resin layer.

10. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and the extrusion die is a circular die, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are co-extruded into a cylindrical form to form the multilayer polyolefin foamed sheet in the co-extruding step, the method further comprising an incising step for incising the cylindrical multilayer polyolefin foamed sheet along its longitudinal direction at two points to form

two multilayer polyolefin foamed sheets, wherein the gas barrier resin sheet is supplied to between the two multilayer polyolefin foamed sheets, which are thereafter laminated to the both surfaces of the gas barrier resin sheet to form the gas barrier resin layer in the laminating step.

11. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and the extrusion die is a circular die, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are co-extruded into a cylindrical form to form the multilayer polyolefin foamed sheet in the co-extruding step, the method further comprising an incising step for incising the cylindrical multilayer polyolefin foamed sheet along its longitudinal direction at two points to form two multilayer polyolefin foamed sheets, wherein the gas barrier resin sheet is supplied onto at least one surface of the two multilayer polyolefin foamed sheets so as to form an outermost layer and the gas barrier resin sheet and the two multilayer polyolefin foamed sheets are laminated together to form the gas barrier resin layer in the laminating step.

12. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and the extrusion die is a circular die, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are co-extruded into a cylindrical form to form the multilayer polyolefin foamed sheet in the co-extruding step, the method further comprising an incising step for incising the cylindrical multilayer polyolefin foamed sheet along its longitudinal direction at one point,

wherein the gas barrier resin sheet is supplied onto at least one surface of the two multilayer polyolefin foamed sheets and the gas barrier resin sheet and the two multilayer polyolefin foamed sheet are laminated together to form the gas barrier resin layer.

13. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and the extrusion die is one flat die which has two extrusion openings parallel to each other, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are supplied to the extrusion openings of the extrusion die to be co-extruded to form two multilayer polyolefin foamed sheets in the co-extruding step, wherein the gas barrier resin sheet is supplied to between the two multilayer polyolefin foamed sheets and laminated therewith to form the gas barrier resin layer in the laminating step.

14. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and the extrusion die is one flat die which has two extrusion openings parallel to each other, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are supplied to the extrusion openings of the extrusion die to be co-extruded to form two multilayer polyolefin foamed sheets in the co-extruding step, wherein the gas barrier resin sheet is supplied onto at least one surface of the two multilayer polyolefin foamed sheets so as to form an outermost layer and the gas barrier resin sheet and the two multilayer polyolefin foamed sheets are laminated together to form the gas barrier

resin layer in the laminating step.

15. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and two flat dies, each of which has one parallel extrusion opening, are provided as the extrusion die, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are respectively supplied to the extrusion openings of the two dies and co-extruded to form two multilayer polyolefin foamed sheets in the co-extruding step, wherein the gas barrier resin sheet is supplied to between the two multilayer polyolefin foamed sheets and laminated together to form the gas barrier resin layer in the laminating step.

16. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein one first extruder and one second extruder are provided and two flat dies, each of which has one parallel extrusion opening, are provided as the extrusion die, wherein the material for forming a polyolefin foamed layer and the material for forming a polyolefin non-foamed layer are respectively supplied to the extrusion openings of the two dies and co-extruded to form two multilayer polyolefin foamed sheets in the co-extruding step, wherein the gas barrier resin sheet is supplied onto at least one surface of the two multilayer polyolefin foamed sheets so as to form an outermost layer and the gas barrier resin sheet and the two multilayer polyolefin foamed sheets are laminated together to form the gas barrier resin layer in the laminating step.

17. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein two first extruders and two second extruders

are provided, wherein two flat dies, each of which has one extrusion opening, or two circular dies are provided as the extrusion die, wherein the method uses two sets of producing apparatus comprising one first extruder, one second extruder and one extrusion die, wherein the material for forming a polyolefin foamed layer and the material for forming the polyolefin non-foamed layer are supplied to the two sets of manufacturing apparatus and co-extruded to form two multilayer polyolefin foamed sheets in the co-extruding step, wherein the gas barrier resin sheet is supplied to between the two multilayer polyolefin foamed sheets and laminated together to form the gas barrier resin layer in the laminating step.

18. The method for producing a multilayer polyolefin foamed sheet according to claim 9, wherein two first extruders and two second extruders are provided, wherein two flat dies, each of which has one extrusion opening, or two circular dies are provided as the extrusion die, wherein the method uses two sets of producing apparatus comprising one first extruder, one second extruder and one extrusion die, wherein the material for forming a polyolefin foamed layer and the material for forming the polyolefin non-foamed layer are supplied to the two sets of manufacturing apparatus and co-extruded to form two multilayer polyolefin foamed sheets in the co-extruding step, wherein the gas barrier resin sheet is supplied onto at least one surface of the two multilayer polyolefin foamed sheets so as to form an outermost layer and the gas barrier resin sheet and the two multilayer polyolefin foamed sheets are laminated together to form the gas barrier resin layer in the laminating step.

19. The method for producing a multilayer polyolefin foamed sheet



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according to claim 1, further comprising a pressure reducing step for passing the extruded multilayer polyolefin foamed sheet through a vacuum chamber to increase an expansion ratio of the foamed layer.

20. The method for producing a multilayer polyolefin foamed sheet according to claim 19, wherein the extrusion die is a circular die and wherein the vacuum chamber is jointed to the circular die and comprises an inner cylinder and an outer cylinder covering the inner cylinder.

21. An apparatus for producing a polyolefin foamed sheet comprising:

at least one extruder equipped with a foaming agent-supplying device for supplying a foaming agent, wherein in the extruder, a resin material for forming a polyolefin foamed layer is melted and the melted resin material for forming a polyolefin foamed layer and the foaming agent are mixed to form a material for forming a polyolefin foamed layer,

a circular die mounted to the extruder, through which the material for forming a polyolefin foamed layer is extruded into a cylindrical form, and

a vacuum chamber for converting the material for forming a polyolefin foamed layer into foam, wherein the vacuum chamber is jointed to the circular die and comprises an inner cylinder and an outer cylinder covering the inner cylinder.

22. The apparatus for producing a polyolefin foamed sheet according to claim 21, wherein the circular die is further equipped with at least one extruder for extruding a material for forming a polyolefin non-foamed layer and wherein the circular die is a multilayer-forming circular die which can produce a multilayer polyolefin foamed sheet comprising at least one polyolefin foamed layer and at least one polyolefin non-foamed layer by co-

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extruding the material for forming the foamed layer and the material for forming the non-foaming layer in their melted states.

23. The apparatus for producing a polyolefin foamed sheet according to claim 21 or 22, wherein the inner cylinder is a mandrel which can enlarge a diameter of the cylindrical sheet extruded.

24. The apparatus for producing a polyolefin foamed sheet according to claim 21 or 22, further having a sealing member for sealing the vacuum chamber on at least one of the outer periphery of the inner cylinder and the inner periphery of the outer cylinder.

25. The apparatus for producing a polyolefin foamed sheet according to claim 21 or 22, wherein fine irregularities are provided on at least one of the outer periphery of the inner cylinder and a surface of the outer cylinder which is to face the resin material for forming a polyolefin foamed layer.

26. The apparatus for producing a polyolefin foamed sheet according to claim 21 or 22, at least one of the inner cylinder and the outer cylinder has a temperature-controlling means.

27. The apparatus for producing a polyolefin foamed sheet according to claim 21 or 22, wherein a gear pump is placed between the circular die and at least one of the extruders.

28. The method for producing a multilayer polyolefin foamed sheet according to claim 1, further comprising an extending step for extending the co-extruded multilayer polyolefin foamed sheet in a direction perpendicular to the extruding direction by means of an extending device, wherein the extending step is conducted after the co-extruding step.

29. The method for producing a multilayer polyolefin foamed sheet

according to claim 28, wherein the extending device is a mandrel.

30. The method for producing a multilayer polyolefin foamed sheet according to claim 28, wherein an extending ratio achieved in the extending step is from 1.5 times to 4.5 times.

31. The method for producing a multilayer polyolefin foamed sheet according to claim 6 or 19, further comprising a preheating step for preheating the extruded multilayer polyolefin foamed sheet, wherein the preheating step is conducted before at least one of the laminating step and the pressure reducing step.

32. A multilayer polyolefin foamed sheet comprising a foamed layer and a non-foamed layer, wherein the foamed layer is composed of polyolefin and the non-foamed layer is composed of one of the polyolefins, a polypropylene with a long-chain branch and a polyolefin-based adhesive resin with a long-chain branch.

33. The multilayer polyolefin foamed sheet according to claim 32, wherein the polyolefin forming the non-foamed layer has a branching index, [A], satisfying  $0.20 \leq [A] \leq 0.98$ .

34. The multilayer polyolefin foamed sheet according to claim 32, wherein the sheet has at least two non-foamed layers and has a structure of non-foamed layer/foamed layer/non-foamed layer.

35. The multilayer polyolefin foamed sheet according to claim 32, wherein the sheet has at least three non-foamed layers.

36. The multilayer polyolefin foamed sheet according to claim 32, wherein the foamed layer has an expansion ratio of from 2.5 to 40 times.

37. The multilayer polyolefin foamed sheet according to claim 32,

wherein the foamed layer comprises polypropylene foam.

38. The multilayer polyolefin foamed sheet according to claim 32, wherein a gas barrier resin sheet with at least one gas barrier resin layer is laminated.

39. The multilayer polyolefin foamed sheet according to claim 38, wherein the barrier resin sheet has a thickness of from 10 to 300  $\mu\text{m}$  and has a thickness distribution,  $T_{\text{max}}/T_{\text{min}}$ , of from 1 to 1.2 in an area of at least 25  $\text{cm}^2$ .

40. A multilayer polyolefin foamed sheet comprising a foamed sheet having at least one polyolefin foamed layer and a gas barrier resin sheet having at least one barrier resin layer laminated thereon, wherein the gas barrier resin sheet has a thickness of from 10 to 300  $\mu\text{m}$  and has a thickness distribution,  $T_{\text{max}}/T_{\text{min}}$ , of from 1 to 1.2 in an area of at least 25  $\text{cm}^2$ .

41. The multilayer polyolefin foamed sheet according to claim 39, further comprising at least one polyolefin non-foamed layer.

42. The multilayer polyolefin foamed sheet according to claim 40 or 41, wherein a content of a low-molecular-weight organic compound with from 3 to 4 carbon atoms is not greater than 10000 ppm.

43. The multilayer polyolefin foamed sheet according to claim 40, wherein the gas barrier resin layer has a thickness of from 10 to 150  $\mu\text{m}$ .

44. The multilayer polyolefin foamed sheet according to claim 41, wherein the non-foamed layer has a surface roughness,  $R_a$ , satisfying  $R_a \leq 4 \mu\text{m}$  and a thickness of not less than 5  $\mu\text{m}$ .

45. A foamed container body formed of the multilayer polyolefin foamed sheet according to claim 44, wherein the part surrounding its opening can be

sealed directly with a covering member and wherein at least the sealed part in the part surrounding the opening has a non-foamed layer.

46. A polyolefin foamed container body wherein the part surrounding its opening can be directly sealed with a covering member, wherein at least the sealed part in the part surrounding the opening has a non-foamed layer and wherein the non-foamed layer has a surface roughness,  $R_a$ , satisfying  $R_a \leq 4 \mu\text{m}$  and a thickness of not less than  $5 \mu\text{m}$ .

47. A foamed container comprising the foamed container body according to claim 45 or 46 and a covering member which can seal the opening of the foamed container body.

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